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(71)Applicant : HIRAI KEITA

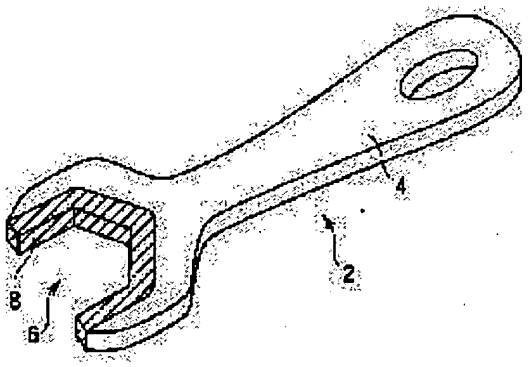
(72)Inventor : HIRAI KEITA

(54) TITANIUM ALLOY TOOL AND MANUFACTURING METHOD OF THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a titanium alloy tool that suppresses an increase in manufacturing cost, has high hardness and wear resistance and has high toughness and elasticity, in a titanium alloy tool such as cutting pliers and a wrench manufactured by a powder molding and sintering method, and a manufacturing method thereof.

SOLUTION: The titanium alloy tool 2 manufactured by a powder molding and sintering method has a first metal layer of relatively low hardness, and a second metal layer of relatively high hardness formed in a region near a holding surface 8 of a holding portion 6.



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CLAIMS

[Claim(s)]
[Claim 1] The tool made from a titanium alloy which is a tool made from a titanium alloy manufactured by the powder-molding sintering process, and is characterized by having the 1st metal layer which has a predetermined degree of hardness, and the 2nd metal layer which is formed in a desired field and has a degree of hardness higher than said predetermined degree of hardness.
[Claim 2] It is the tool made from a titanium alloy characterized by being the pure titanium layer or titanium-alloy layer in which said 1st metal layer has a 40 or less-HRC degree of hardness in the tool made from a titanium alloy according to claim 1.
[Claim 3] It is the tool made from a titanium alloy characterized by being the titanium-alloy layer in which said 2nd metal layer has a degree of hardness not more than more than HRC40 60 in the tool made from a titanium alloy according to claim 1 or 2.
[Claim 4] It is the tool made from a titanium alloy characterized by said 2nd metal layer having 30% or less of volume of a whole product in the tool made from a titanium alloy given in claim 1 thru/or any 1 term of 3.
[Claim 5] It is filled up with the 1st raw material powder with which the pure titanium layer or titanium-alloy layer which has a predetermined degree of hardness when it sinters at predetermined temperature to the metal mold for obtaining the sintering object of a predetermined configuration is obtained. The manufacture approach of the tool made from a titanium alloy characterized by being filled up with the 2nd raw material powder with which the titanium-alloy layer which has a degree of hardness higher than said 1st raw material powder is obtained if it sinters at said predetermined temperature to a desired field among said metal mold, and carrying out shaping sintering of said 1st and 2nd raw material powder at said predetermined temperature.
[Claim 6] The manufacture approach of the tool made from a titanium alloy characterized by having further the process which the press press forging of all or some of shaping sintering objects formed with said 1st and 2nd raw material powder be carried out [process] , and raise an organization consistency in order to raise reinforcement , a metal consistency , etc. in said predetermined configuration in the manufacture approach of the tool made from a titanium alloy according to claim 5 .

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the tool made from a titanium alloy and its manufacture approaches, such as a spanner manufactured by the powder-molding sintering process, and a driver.
[0002]
[Description of the Prior Art] Pure titanium and a titanium alloy are the useful materials of the various industrial products which have lightweight and high elasticity and have the descriptions, such as non-rust and nonmagnetic. However, it is thought that it is unsuitable as a material of activity tools, such as a spanner, a driver, etc. which require a high degree of hardness and abrasion resistance, since neither pure titanium nor a titanium alloy can perform general hardening unlike carbon steel. Moreover, if additives, such as a ceramic and a metallic carbide particle, are mixed to pure titanium powder or titanium-alloy powder and shaping sintering is carried out in order to raise a degree of hardness for example, the fall (fall of anti-****) of a toughness value will arise with the rise of a degree of hardness. Therefore, since risk, such as breakage, will arise if it uses as a material of the activity tool which a big load requires, as a material of an activity tool, it is unsuitable. Moreover, if expensive additives, such as a ceramic and metallic carbide, are mixed, a material will become expensive, and the unsuitable thing is known by the activity tool of which **** is required. Therefore, since the degree of hardness and abrasion resistance which are required of the edge of a blade, the pinching section, etc. are not enough, either, while it is very expensive, the tool made from a titanium alloy is used only for the former part.
[0003]
[Problem(s) to be Solved by the Invention] As mentioned above, when a degree of hardness and abrasion resistance were raised, toughness and elasticity fell, and the problem of having brittleness has produced the tool made from a titanium alloy. Moreover, as mentioned above, since mixing an additive to pure titanium powder or the whole titanium-alloy powder becomes the factor which the manufacturing cost of the tool made from a titanium alloy increases, the problem that the economical efficiency of the tool made from a titanium alloy falls has arisen.
[0004] The purpose of this invention is to offer the tool made from a titanium alloy which has high toughness and elasticity while it suppresses a manufacture increase in cost and has a high degree of hardness and abrasion resistance.
[0005]
[Means for Solving the Problem] The above-mentioned purpose is a tool made from a titanium alloy manufactured by the powder-molding sintering process, and is attained by the tool made from a titanium alloy characterized by having the 1st metal layer which has a predetermined degree of hardness, and the 2nd metal layer which is formed in a desired field and has a degree of hardness higher than said predetermined degree of hardness.
[0006] It is the tool made from a titanium alloy of above-mentioned this invention, and said 1st metal layer is characterized by being the pure titanium layer or titanium-alloy layer which has a 40 or less-HRC degree of hardness. Moreover, it is the tool made from a titanium alloy of above-mentioned this

invention, and said 2nd metal layer is characterized by being the titanium-alloy layer which has a degree of hardness not more than more than HRC40 60. Furthermore, it is the tool made from a titanium alloy of above-mentioned this invention, and said 2nd metal layer is characterized by having 30% or less of volume of a whole product.

[0007] The above-mentioned purpose among the metal mold for obtaining the sintering object of a predetermined configuration moreover, to a desired field It is filled up with the 1st raw material powder with which the titanium-alloy layer which has a predetermined degree of hardness when it sinters at predetermined temperature is obtained. It is filled up with the 2nd raw material powder with which the pure titanium layer or titanium-alloy layer which has toughness higher than the 1st [said] raw material powder and a degree of hardness lower than said predetermined degree of hardness when it sinters at said predetermined temperature to fields other than the field of said request of said metal mold is obtained. It is attained by the manufacture approach of the tool made from a titanium alloy characterized by carrying out shaping sintering of said 1st and 2nd raw material powder at said predetermined temperature.

[0008] It is characterized by having further the process which the press press forging of all or some of shaping sintering objects which was the manufacture approaches of the tool made from a titanium alloy of above-mentioned this invention , and was formed with said 1st and 2nd raw material powder in order to raise reinforcement , a metal consistency , etc. in said predetermined configuration is carried out [process] , and raises an organization consistency .

[0009]

[Embodiment of the Invention] The tool made from a titanium alloy by the gestalt and its manufacture approach of operation of the 1st of this invention are explained using drawing 1 . Drawing 1 is the perspective view showing the configuration of the spanner 2 of the tool made from a titanium alloy by the gestalt of this operation. The spanner 2 has the pedicel 4. The pedicel 4 is comparatively formed in the 1st metal layer with high toughness and elasticity with a low degree of hardness. The 1st metal layer is the pure titanium layer or titanium-alloy layer which shaping sintering was carried out and was formed in the 40 or less Rockwell hardness C (HRC) degree of hardness.

[0010] The pinching section 6 which pinches the bolt head and nut (not shown [both]) of a pinched object is formed in the end of a pedicel 4. Desired fields, such as an about eight pinching side [which contacts a pinched object among the pinching sections 6] field (field shown with the slash in drawing), are formed in the 2nd metal layer with a degree of hardness higher than the 1st metal layer which forms a pedicel 4 in order to prevent wear of the pinching side 8 etc. The 2nd metal layer mixes additives, such as a ceramic and a metallic carbide particle, is a titanium-alloy layer which shaping sintering was carried out and was formed in the degree of hardness not more than more than HRC40 60, and has 30% or less of volume of the whole spanner 2 product. Fields other than about eight pinching side are formed in the 1st same metal layer as a pedicel 4. In addition, the 1st and 2nd metal layers contain titanium 50% or more.

[0011] Thus, it is formed in the pure titanium layer only with a degree of hardness it is formed in a titanium-alloy layer with a high degree of hardness, and low about other fields, and the desired high field where a degree of hardness and abrasion resistance with an expensive spanner 2 are demanded on a function or titanium-alloy layer of toughness and elasticity.

[0012] Next, the manufacture approach of the tool made from a titanium alloy by the gestalt of this operation is explained. First, desired fields, such as an about eight pinching side field, are filled up with the 2nd raw material powder among the metal mold (not shown) for obtaining the sintering object of a predetermined configuration. If the 2nd raw material powder makes pure titanium powder or titanium-alloy powder mix additives, such as a ceramic and a metallic carbide particle, and is sintered at predetermined temperature, a titanium-alloy layer with a comparatively high degree of hardness will be obtained.

[0013] Next, fields of an except, such as about eight pinching side, are filled up with the 1st raw material powder. The 1st raw material powder is pure titanium powder, 6 A4V powder, or a beta titanium alloy, and if it sinters at predetermined temperature, a pure titanium layer with high toughness and elasticity

with a degree of hardness lower than the titanium-alloy layer obtained from the 2nd raw material powder or a titanium-alloy layer will be obtained.

[0014] Next, the raw material powder with which it filled up is pressed. Next, the raw material powder by which compression molding was carried out is sintered at predetermined temperature (1000 degrees C - 1400 degrees C). Moreover, in order to raise reinforcement, a metal consistency, etc. in a predetermined configuration, the press press forging of all or some of obtained shaping sintering objects may be carried out, and an organization consistency may be raised. The tool made from a titanium alloy by the gestalt of this operation is completed through the above process.

[0015] In addition, since the obstruction is not formed between the field in which a titanium-alloy layer with a high degree of hardness is formed, and the other field, the 1st and 2nd raw material powder with which metal mold was filled up is mutually mixed with metal mold on the boundary of the two above-mentioned fields. Therefore, near the bonding site of both the metal layer that was sintered and was really stratified, the sintering boundary layer by the titanium particle of the principal member of both the metal layer carrying out sintering association is formed.

[0016] According to the gestalt of this operation, since the about eight pinching side [of the pinching section 6] field is formed in the 2nd metal layer with a comparatively high degree of hardness, the tool made from a titanium alloy which has the abrasion resistance superior to the tool formed only in the 1st metal layer is realizable. Moreover, since fields other than about eight pinching side are formed in the 1st metal layer with high toughness and elasticity with a comparatively low degree of hardness, the tool made from a titanium alloy which has toughness and elasticity higher than the tool formed only in the 2nd metal layer is realizable. Furthermore, since the additive is mixed only to some fields, a manufacture increase in cost can be suppressed.

[0017] Next, the tool made from a titanium alloy by the gestalt of operation of the 2nd of this invention is explained using drawing 2 . Drawing 2 is the perspective view showing the configuration of the monkey wrench 10 of the tool made from a titanium alloy by the gestalt of this operation. The monkey wrench 10 has the pedicel 4. The pedicel 4 is comparatively formed in the 1st metal layer with high toughness and elasticity with a low degree of hardness. The 1st metal layer is the pure titanium layer or titanium-alloy layer which shaping sintering was carried out and was formed in the 40 or less-HRC degree of hardness.

[0018] The fixed jaw 12 which constitutes one side of the pinching section 6 which pinches the bolt head and nut (not shown [both]) of a pinched object is formed in the end of a pedicel 4. The fixed jaw 12 has the pinching side 18 in contact with a pinched object. Moreover, the fixed jaw 12 is countered and the movable jaw 14 which constitutes another side of the pinching section 6 is arranged. The movable jaw 14 has the pinching side 16 in contact with a pinched object. Both the pinching sides 16 and 18 are arranged so that it may become parallel mutually. Moreover, the movable jaw 14 moves by rotating **** of the actuation thread part 20 prepared in the end of a pedicel 4, maintaining the parallel condition of both the pinching sides 16 and 18.

[0019] Among the pinching sections 6, an about 18 pinching side [of the fixed jaw 12] field and desired fields, such as an about 16 pinching side [of the movable jaw 14] field (field shown with the slash in drawing), are formed in the 2nd metal layer with a degree of hardness higher than the 1st metal layer which forms a pedicel 4 in order to prevent wear of the pinching sides 16 and 18 etc. The metal layer concerned mixes additives, such as a ceramic and a metallic carbide particle, is a titanium-alloy layer which shaping sintering was carried out and was formed in the degree of hardness not more than more than HRC40 60, and has less than 30% of volume of the whole monkey-wrench 10 product. Fields other than 16 or about 18 pinching side are formed in the 1st same metal layer as a pedicel 4. In addition, the 1st and 2nd metal layers contain titanium 50% or more.

[0020] According to the gestalt of this operation, like the gestalt of implementation of the above 1st, since the 16 or about 18 pinching side field is formed in the 2nd metal layer with a comparatively high degree of hardness, the tool made from a titanium alloy which has the abrasion resistance superior to the tool formed only in the 1st metal layer is realizable. Moreover, since fields other than 16 or about 18 pinching side are formed in the 1st metal layer with high toughness and elasticity with a comparatively

low degree of hardness, the tool made from a titanium alloy which has toughness and elasticity higher than the tool formed only in the 2nd metal layer is realizable. Furthermore, since the additive is mixed only to some fields, a manufacture increase in cost can be suppressed.

[0021] Next, the tool made from a titanium alloy by the gestalt of the 3rd operation is explained using drawing 3 . Drawing 3 is the perspective view showing the configuration of the cutting pliers (cutting pliers) 22 of the tool made from a titanium alloy by the gestalt of this operation. Cutting pliers 22 have the grasping sections 24a and 24b of a pair. The grasping sections 24a and 24b are comparatively formed in the 1st metal layer with high toughness and elasticity with a low degree of hardness. The 1st metal layer is the pure titanium layer or titanium-alloy layer which shaping sintering was carried out and was formed in the 40 or less-HRC degree of hardness.

[0022] The pinching sections 7a and 7b of a pair are formed in the end of the grasping sections 24a and 24b through the shank 27. Desired fields, such as a field pinching side 26a which contacts a pinched object among the pinching sections 7a and 7b, and near the 26b (field shown with the slash in drawing), are formed in the 2nd metal layer with a degree of hardness higher than the 1st metal layer which forms the grasping sections 24a and 24b in order to prevent wear of the pinching sides 26a and 26b etc. The 2nd metal layer mixes additives, such as a ceramic and a metallic carbide particle, is a titanium-alloy layer which shaping sintering was carried out and was formed in the degree of hardness not more than more than HRC40 60, and has 30% or less of volume of the whole cutting-pliers 22 product. Fields other than pinching side 26a and near the 26b are formed in the 1st same metal layer as the grasping sections 24a and 24b. In addition, the 1st and 2nd metal layers contain titanium 50% or more.

[0023] According to the gestalt of this operation, like the gestalt of the above 1st and the 2nd implementation, since the field pinching side 26a and near the 26b is formed in the 2nd metal layer with a comparatively high degree of hardness, the tool made from a titanium alloy which has the abrasion resistance superior to the tool formed only in the 1st metal layer is realizable. Moreover, since fields other than pinching side 26a and near the 26b are formed in the 1st metal layer with high toughness and elasticity with a comparatively low degree of hardness, the tool made from a titanium alloy which has toughness and elasticity higher than the tool formed only in the 2nd metal layer is realizable. Furthermore, since the additive is mixed only to some fields, a manufacture increase in cost can be suppressed.

[0024] Next, the tool made from a titanium alloy by the gestalt of the 4th operation is explained using drawing 4 . Drawing 4 is the perspective view showing the configuration of the nipper 38 of the tool made from a titanium alloy by the gestalt of this operation. The nipper 28 has the grasping sections 40a and 40b of a pair. Comparatively, a degree of hardness is formed in the 1st low metal layer with high toughness and elasticity, and the grasping sections 40a and 40b are covered with resin etc. The 1st metal layer is the pure titanium layer or titanium-alloy layer which shaping sintering was carried out and was formed in the 40 or less-HRC degree of hardness.

[0025] The cutting sections 44a and 44b of a pair are formed in the end of the grasping sections 40a and 40b through the shank 42. The field cutting part 46a which cuts sections-ed covered with vinyl etc. among the cutting sections 44a and 44b, such as copper wire and a wire, and near the 46b (field shown with the slash in drawing) is formed in the 2nd metal layer with a degree of hardness higher than the 1st metal layer which forms the grasping sections 40a and 40b in order to prevent wear of cutting parts 46a and 46b etc. The 2nd metal layer mixes additives, such as a ceramic and a metallic carbide particle, is a titanium-alloy layer which shaping sintering was carried out and was formed in the degree of hardness not more than more than HRC40 60, and has 30% or less of volume of the whole nipper 38 product. Fields other than cutting part 46a and near the 46b are formed in the 1st same metal layer as the grasping sections 24a and 24b. In addition, the 1st and 2nd metal layers contain titanium 50% or more.

[0026] According to the gestalt of this operation, like the gestalt of the above 1st thru/or the 3rd implementation, since the field cutting part 46a and near the 46b is formed in the 2nd metal layer with a comparatively high degree of hardness, the tool made from a titanium alloy which has the abrasion resistance superior to the tool formed only in the 1st metal layer is realizable. Moreover, since fields other than cutting part 46a and near the 46b are formed in the 1st metal layer with high toughness and

elasticity with a comparatively low degree of hardness, the tool made from a titanium alloy which has toughness and elasticity higher than the tool formed only in the 2nd metal layer is realizable. Furthermore, since the additive is mixed only to some fields, a manufacture increase in cost can be suppressed.

[0027] Next, the tool made from a titanium alloy by the gestalt of operation of the 5th of this invention is explained using drawing 5 . Drawing 5 is the perspective view showing the configuration of the driver 28 of the tool made from a titanium alloy by the gestalt of this operation. The driver 28 has the shaft 30. The shaft 30 is comparatively formed in the 1st metal layer with high toughness and elasticity with a low degree of hardness. The 1st metal layer is the pure titanium layer or titanium-alloy layer which shaping sintering was carried out and was formed in the 40 or less-HRC degree of hardness.

[0028] The edge of a blade 32 which has configurations, such as plus and minus, is formed in the end of a shaft 30. Desired fields, such as an about 32 edge of a blade field (field shown with the slash in drawing), are formed in the 2nd metal layer with a degree of hardness higher than the 1st metal layer which forms a shaft 30 in order to prevent the wear at the time of contacting the screw-thread pore (not shown) of an object etc. The 2nd metal layer mixes additives, such as a ceramic and a metallic carbide particle, is a titanium-alloy layer which shaping sintering was carried out and was formed in the degree of hardness not more than more than HRC40 60, and has 30% or less of volume of the whole driver 28 product. The other end of a shaft 30 is being fixed by the pedicel 4.

[0029] According to the gestalt of this operation, like the gestalt of the above 1st thru/or the 4th implementation, since the about 32 edge of a blade field is formed in the 2nd metal layer with a comparatively high degree of hardness, the tool made from a titanium alloy which has the abrasion resistance superior to the tool formed only in the 1st metal layer is realizable. Moreover, since the shaft 30 is formed in the 1st metal layer with high toughness and elasticity with a comparatively low degree of hardness, the tool made from a titanium alloy which has toughness and elasticity higher than the tool formed only in the 2nd metal layer is realizable. Furthermore, since the additive is mixed only to some fields, a manufacture increase in cost can be suppressed.

[0030] Not only the gestalt of the above-mentioned implementation but various deformation is possible for this invention. For example, with the gestalt of the above 1st thru/or the 5th implementation, although the tool of a spanner 2, cutting pliers 22, and nipper 38 grade was explained, this invention is applicable not only to this but other tools, such as long-nose pliers, a hammer, and a chisel. Furthermore, this invention is applicable also to the ice ax 34 grade for mountain climbing as shown in drawing 6 . The ice ax 34 is formed in the titanium-alloy layer in which the point 33 which requires a high degree of hardness and abrasion resistance among the head sections 36, and about 35 cutting part field (field shown with the slash in drawing) has a degree of hardness higher than other fields. Thus, this invention is applicable to various titanium-alloy products including mountain-climbing equipment by considering as the above 1st thru/or the same configuration as the gestalt of the 5th operation.

[0031]

[Effect of the Invention] While according to this invention the above passage suppressing a manufacture increase in cost and having a high degree of hardness and abrasion resistance, the tool made from a titanium alloy which has high toughness and elasticity can be manufactured.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view showing the configuration of the tool made from a titanium alloy by the gestalt of operation of the 1st of this invention.
[Drawing 2] It is the perspective view showing the configuration of the tool made from a titanium alloy by the gestalt of operation of the 2nd of this invention.
[Drawing 3] It is the perspective view showing the configuration of the tool made from a titanium alloy by the gestalt of operation of the 3rd of this invention.
[Drawing 4] It is the perspective view showing the configuration of the tool made from a titanium alloy by the gestalt of operation of the 4th of this invention.
[Drawing 5] It is the perspective view showing the configuration of the tool made from a titanium alloy by the gestalt of operation of the 5th of this invention.
[Drawing 6] It is the perspective view showing the modification of the gestalt of the 1st thru/or operation of the 5th of this invention.
[Description of Notations]
2 Spanner
4 Pedicel
6, 7a, 7b Pinching section
8, 16, 18, 26a, 26b Pinching side
10 Monkey Wrench
12 Fixed Jaw
14 Movable Jaw
20 Actuation Thread Part
22 Cutting Pliers
24a, 24b, 40a, 40b Grasping section
27 42 Shank
28 Driver
30 Shaft
32 Edge of a Blade
33 Point
34 Ice Ax
35, 46a, 46b Cutting part
36 Head Section
38 Nipper

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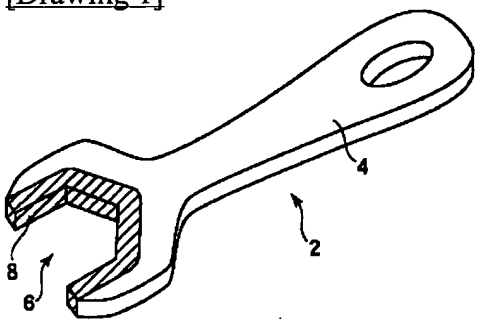
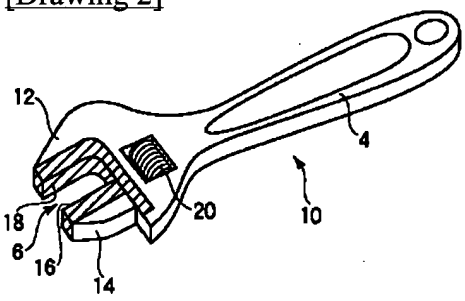
DRAWINGS

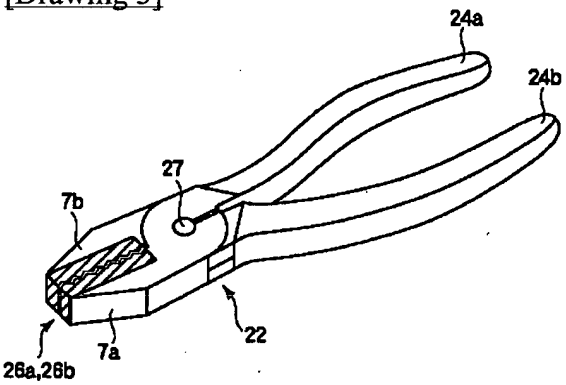
[Drawing 1]



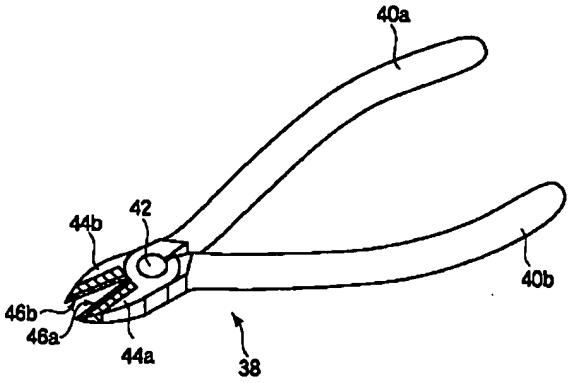
[Drawing 2]



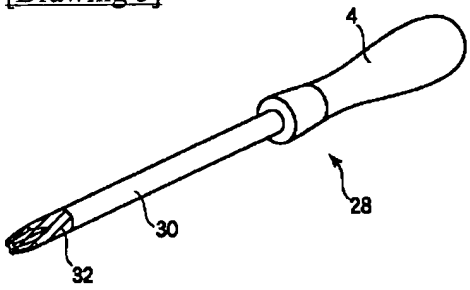
[Drawing 3]



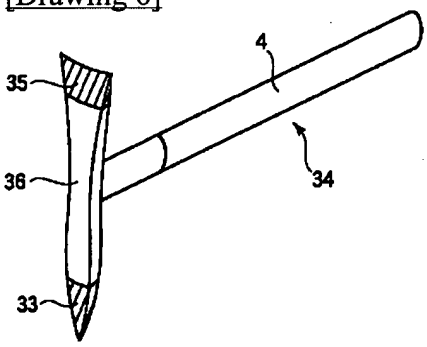
[Drawing 4]



[Drawing 5]



[Drawing 6]



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